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UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF ENTOMOLOGY  
FOREST INSECT INVESTIGATIONS

PHLOEM MOISTURE AND BEETLE SUSCEPTIBILITY  
OF WESTERN YELLOW PINE

by

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Portland, Oregon  
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PHLOEM MOISTURE AND BEETLE SUSCEPTIBILITY  
OF WESTERN YELLOW PINE

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Undoubtedly there is a high degree of host selection among many insects. Some of the bark-beetles exhibit this tendency to a marked degree, and the reason for it has been a subject of much study and discussion by foresters and entomologists alike. In the case of the western pine beetle (Dendroctonus brevicomis Lec.), a suitable explanation for this selection has not been advanced. Whether it is food requirements, tree vigor, site, or moisture relation which regulates selection is not known.

The detrimental effect of moisture on developing barkbeetle broods and the beneficial effect of drought has been pretty well established (1). Outbreaks of the western pine beetle have also been found to be pretty closely correlated with long periods of dry weather (2). Since moisture apparently plays such an important role in barkbeetle epidemics, the idea suggested itself that moisture was also an important factor influencing tree selection by the western pine beetle. It was therefore decided to compare phloem moisture by crown class on a small group of western yellow pine with the beetle susceptibility as worked out during previous studies on the western pine beetle.

The Insect Surveys on the Southern Oregon-Northern California Project, which started in 1921, and have been conducted by Keen, have accumulated considerable data on the size, crown classes and growth rate

(1) Craighead, Jour. Eco. Ent. Vol. 18, No. 4, 1925.

(2) Craighead, Jour. For. Vol. 23, April, 1925.

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of trees killed by barkbeetles - mainly the western pine beetle. The studies on this beetle have shown it to be highly selective on western yellow pine, its natural host. Person (3) has shown on the Cascade Area of the Sierra National Forest, California, that the loss varied inversely with the quality of the site, the heaviest losses being found on the poorest sites; that a decided preference is shown by this beetle for trees between 20 and 30 inches DBH, and that the beetles selected the more slowly growing trees in 75 per cent of the cases studied.

Although it has been fully demonstrated that the beetles show a decided preference for certain classes of trees, usually slow growing, overmature and suppressed trees, the reason for this selection has not been discovered. In this paper, phloem moisture is correlated with beetle loss in an attempt to determine the effect of moisture on tree selection.

The information obtained by Keen during 1927, 1928 and part of 1929 on the percentage of beetle-killed trees in the different groups as compared with their occurrence in the stand, is used in the comparison of phloem moisture with susceptibility of the trees. These data on susceptibility include some 15,096 beetle trees and 10,607 green trees which were examined, tallied, and grouped according to crown class. The tree classification used in this study is an elaboration of Dunning's (4) tree classification as used by Keen. Under this classification the trees are grouped into four age classes which are further subdivided into four crown classes making a total of sixteen classes in all. The four general age groups are - young (less than 75 years), thrifty mature (75 to 150 years), mature (150 to 300 years) and overmature (over 300 years). Crown class

(3) Person, Jour. For. Vol. 26, No. 5, May, 1928.

(4) Dunning, Jour. Agr. Res. Vol. 36, No. 9, May 1, 1928.

is represented in general by the four common crown classes; dominant, 181  
codominant, intermediate and suppressed.

Moisture determinations were made from phloem samples collected from eighty trees on site three of better than average quality. The samples were collected and recorded according to the tree classification already described which was worked out for use on the extensive survey work. All samples were weighed in the field as collected, partially dried out and brought into the laboratory where they were completely dried at 215 Fahrenheit and the moisture percentages computed from the dry weight basis. A total of eighty samples were taken representing the crown classes previously discussed. This gave twenty samples from each age class and five from each crown class.

The phloem moisture and beetle susceptibility according to age groups and crown classes are compared in graph 1. The heavy black bars represent beetle susceptibility and the light bars represent phloem moisture conditions on similar trees. It can be readily seen from the graph that there is a close correlation between phloem moisture and beetle susceptibility as indicated by these figures. The phloem moisture per cent appears to vary with the crown class rather than the age. The (a) crowns with which is associated the highest phloem moisture content show also the minimum loss from beetles. The (b) crowns associated with a somewhat lower phloem moisture per cent show a slightly heavier loss from the beetles. The (c) crowns with a comparatively dry phloem represent the most susceptible group of trees in the whole stand, while the (d) crowns associated with a drier phloem moisture than are the (c)

crowns are less in their susceptibility than (c) trees but suffer heavier losses than either (a) or (b) crowns. It is possible the extreme dryness as found with some of the (d) crowns is not suitable for attack by the western pine beetle. The correlation between phloem moisture and susceptibility is remarkably close except with the single case of class (1d) which is represented by so few trees that very little significance can be attached to this figure. With all of the other fifteen classes, it is felt that a sufficiently large number of trees were obtained to give a fairly accurate picture of the susceptibility of western yellow pine to the western pine beetle.

The phloem moisture data is remarkably uniform throughout the crown classes so that the few figures obtained are probably more representative than their numbers would apply. However, with further sampling there would undoubtedly appear considerable alteration in the order of dryness. For example, (4a) probably does not represent the most moist phloem condition since this would naturally be expected to fall in the younger age classes. Also it is felt that under the age classes (2) and (3), the (d) crowns probably do not carry as much phloem moisture as do the (c) crowns. Aside from these limitations, the correlation between phloem moisture and beetle susceptibility is close enough to be of considerable significance. It is possible, however, that the moisture relation may be linked with some more important factor which is responsible for the selection.

If moisture is shown to be a controlling factor in tree selection by the western pine beetle, then susceptibility will vary with the moisture and will fluctuate from season to season and from year to year.

Rainy seasons and periods of heavy rainfall raise the moisture content of all the trees and would in this way cut down the number of susceptible trees. On the other hand, long periods of dry weather would in the opposite manner decrease the phloem moisture content and result in increasing the number of susceptible trees. This would tie in very well with the theory of the effect of drought on the western pine beetle.

From the above data it may be tentatively concluded that there exists a very close correlation between the phloem moisture content of western yellow pines and their susceptibility to attack by the western pine beetle.

Generally speaking, the moisture of the phloem decreases with the size of the crown, there being little difference in the age classes. The loss by beetles increases as the moisture decreases until a point is reached which appears to be too dry to attract the beetles. This condition is found with (d) crowns.

The preliminary data are significant enough to warrant further sampling for a more complete comparison.

Respectfully Submitted  
J. A. Beal



## COMPARISON OF PHLOEM MOISTURE AND BEETLE SUSCEPTIBILITY OF WESTERN YELLOW PINE

